

Attorney Docket No : 10541-1888

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group Art Unit: 3743

Examiner: Terrell L. McKinnon

Inventors: JAIRAZBHOY, ET AL.

Serial No.: 10/697,839

Filing Date: October 30, 2003

Title: METAL FOAM HEAT SINK

DECLARATION OF  
MOHAN PARUCHURI  
UNDER 37 C.F.R. §1.131

Commissioner for Patents  
U.S. Patent and Trademark Office  
Washington, DC 20231

Dear Sir:

Mohan Paruchuri hereby declares that:

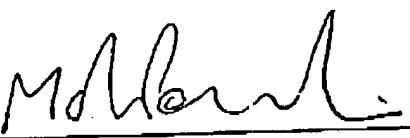
1. I am an inventor of the invention as claimed and described in the above-identified application.
2. I conceived said invention in the United States prior to March 13, 2001, as evidenced by the dated signatures on the second page of the Invention Disclosure form, the written description in the "Description of the Invention" section of the Invention Disclosure form and drawings that are attached to and form a part of the Invention Disclosure form. The Invention Disclosure form being attached hereto as Exhibit A.
3. A prototype of the invention was made prior to the earliest of the dated signatures shown on the Invention Disclosure form.
4. That said invention was diligently worked on from a date prior to March 13, 2001 until the filing date of the instant application, including the fabrication of additional prototypes and testing of the prototypes.

\*\*\* TOTAL PAGE.02 \*\*\*

U.S. Serial No.: 10/054,312

5. All statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statement may jeopardize the validity of the above-identified application, and any patent issuing thereon or any patent to which this declaration is directed.

Dated:

2/1/06  
Mohan Paruchuri

**EXHIBIT A**

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|                               |                                   |   |
|-------------------------------|-----------------------------------|---|
| FOR FGTI<br>GROUP USE<br>ONLY | Attorney<br>LCH<br>TC<br>DP(Mfgr) | Docket Number<br>198-0969<br>Classification |
|-------------------------------|-----------------------------------|---|

Short Descriptive Title of Invention:

Thermal Management with Metal Foam Heat Sink (Note: Related to Super-Integration)

CPSC  
19.00

|  |   |  |  |   |                             |
|--|---|--|--|---|-----------------------------|
| Inventor's Full Name (Include Middle Name):<br>Vivek Jairazbhoy  | Inventor's Full Name (Include Middle Name):<br>Mohan Panichur | Inventor's Full Name (Include Middle Name):  |  |   |                             |
| Inventor's OV ID:<br>VJAIRAZB  | Inventor's OV ID:<br>MPARUCHU                                 | Inventor's OV ID:  |  |   |                             |
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| Job Title:<br>Tech. Specialist   | Organization/Business Unit:<br>ELD - Visteon                  | Job Title:<br>Mfg. Engineer  | Organization/Business Unit:<br>ELD - Visteon | Job Title:  | Organization/Business Unit: |
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| Department Name & Number:<br>Adv. Technology Development, E171   |   | Department Name & Number:<br>ATD, E171   |  | Department Name & Number:   |                             |
| Supervisor's Name, Phone No., and OV ID  |   | Supervisor's Name, Phone No., and OV ID:<br>Brenda Nation, 84-53591, BNATION   |  | Supervisor's Name, Phone No., and OV ID:  |                             |
| Manager's Name, Phone No., and OV ID:<br>Jay Baker, 84-53597, JBAKER6  |   | Manager's Name, Phone No., and OV ID:<br>Jay Baker, 84-53597, JBAKER6  |  | Manager's Name, Phone No., and OV ID:   |                             |

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## COMPLETE THE FOLLOWING AND THE ATTACHED PAGES

1. What do you consider to be the new technology of the invention?

New feature of this technology is to use solid metal-metal foam layered structure for heat sinking and dissipation.

2. Identify the purpose/function of the new technology(s) of the invention and advantages over prior technology.

Advantage over the prior technologies are low cost and much better heat dissipation due to ultra-high surface area.

3. Identify the closest technology, if any, of which you are aware. Provide copies, if available.

Conventional solid metal heat sink.

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April 98

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|--|---|---|
| 4. Identify first dated record(s) of invention.<br>July 1998                         | 5. Date a working model, device or process was or will be completed.<br>September 1998  |   |
| 6. If the invention will be released for production, identify model and year. 2000MY | 7. Identify a government agreement, partnership, consortium, or other company involved with conception or first building of the invention, if any. None |   |
| 8. If disclosed to non-Company personnel, identify recipient and date.<br>None       |   |   |
| 9. Advanced Project No., if any.   | 10. Name of related Technology Council, if any.   | 11. Name of related Technology Forum, if any. |

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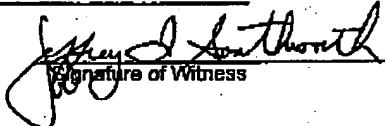
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In confirmation of, and in compliance with obligations I have under an employment agreement or another agreement with the Ford Company and/or in consideration of the Ford Company dealing with this invention disclosure in accordance with the provisions of the Patent Incentive Award Program ("PIAP") applicable to me at the date on which this invention disclosure is received by the FGTI Group, and without prejudice to my statutory rights, if any, I hereby assign, sell and transfer to the Ford Company full and exclusive rights, including copyrights and patent rights, throughout the world to the invention described herein to the extent that such rights do not already vest in the Ford Company by virtue of my employment or otherwise.

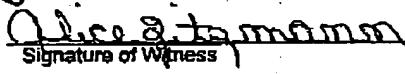
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**READ AND UNDERSTOOD:**

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Signature of Witness Date

 7/23/98  
Signature of Inventor Date

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**DESCRIPTION OF THE INVENTION (USE )**

Provide a written description of the invention, preferably with reference to attached prints, sketches, photos, components, reports, etc. The description should provide a clear, complete understanding of the invention, including its operation and environment. All attachments must be signed by the inventor(s), dated and witnessed.

Heat dissipation from power devices on electronic modules is commonly accomplished with a metal heat sink at the bottom of the device. The heat sink is either solid metal sheet or block with or without fins at the bottom. Fins provide more surface area for heat dissipation. Fin structures with high surface area are bulky and expensive, often requiring machining operations for fabrication.

The present invention provides a structure that uses metal foam instead of fins at the bottom of the metal plate (Fig 1). Metal foams enormous surface area, and hence high heat dissipation. Metal foams can also be used directly as a heat dissipation means, i.e. without a metal plate or heat sink attachment. This configuration would be most appropriate for steady heat removal, in which high area is desirable for heat dissipation, but extra heat capacity provided by a solid attachment to absorb short-term transients is unnecessary. Copper, Aluminum or any other metal or alloys can be used to make the metal foam. Metal foam attached to the solid plate can be made together or separately. The foam and plate can be same metal/alloy or different type. Metal foam sinks are much cheaper than conventional high surface area finned heat sinks.

The metal foam/plate structure can be either planar or three-dimensional with any shape designed to accommodate the heat source. The solid metal plate can be on both sides of the foam also. The applications of this technology are not limited to electronics. It can be used in automotive radiators for better cooling of the engine. Forced air flow or liquid flow through the metal foam can increase the heat dissipation.

Copper metal foam is preferred although Aluminum or other metals can be used. The pores can be various sizes and the wall thickness can be varied also. Metal foam can consist of solid portions and also with varying pore sizes. Solid portions provide heat sinking. Thin layer of thermally conductive adhesive can also be placed between the metal foam and the components to reduce the possibility of shorting to the metal foam. This technology can also be used to package individual components.

Figure 1 shows a metal foam heat sink mounted on the bottom side of a PWB, thermally connected to a heat source ( die/component ) by thermal vias ( conventional SMT ). The integral metal foam heat sink also has an optional solid portion for additional heat capacity, providing the additional thermal mass for heat spreading or sinking. The metal foam provides enormous surface area for heat dissipation at low cost. Although natural convection cooling is possible, best use of the high surface area is made if forced air or liquid cooling is used.

Date and sign every entry. Have every possibly important entry witnessed.  
 Submit an Invention Disclosure of anything possibly new and inventive.

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Metal Foam Heat Sink

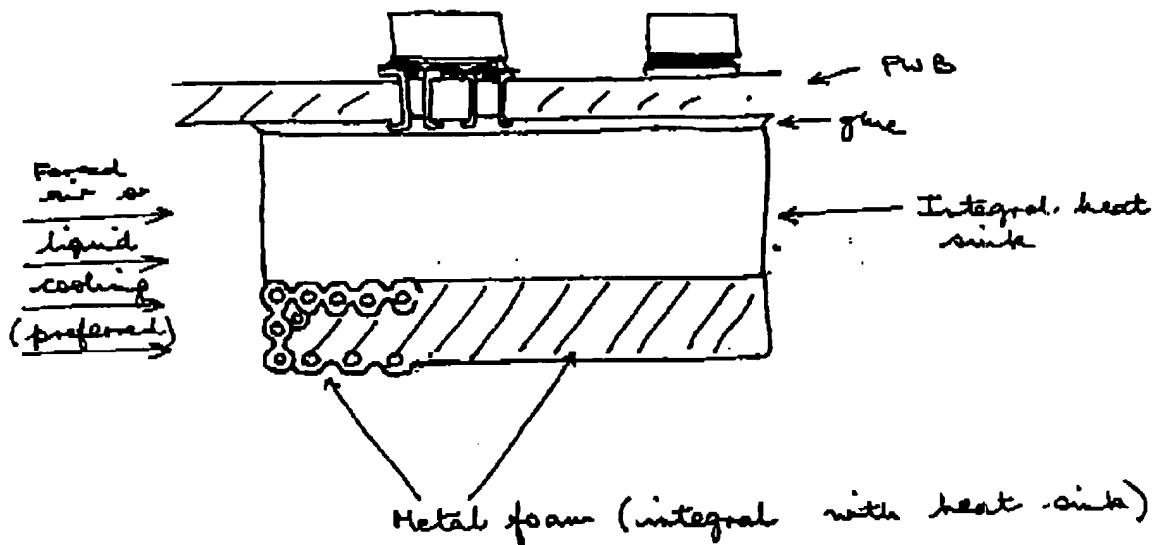


FIGURE 1

Figure 1 shows a metal foam heat sink mounted on the bottom side of a PWB, thermally connected to a heat source (die/component) by metal vias (conventional SMT). Integral metal foam heat sink also has an (optional) solid portion. The solid portion provides the thermal mass for heat spreading or sinking. The metal foam provides extremely large surface area for dissipation to the surroundings. Although natural convection is possible, best use of the high surface area is made if forced air or liquid cooling is used. Advantages:

- (i) Very high surface area.
- (ii) Very low cost compared with (say) highly spined surfaces.

*Victor J. Hoffer* 7/25/98  
 M. Hoffer 7/25/98  
 Date

The above understood  
 and witnessed by *Jeffrey A. Hoffer* 7/23/98  
 Date and  
 by \_\_\_\_\_

*Jeffrey A. Hoffer* 8-11-98